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MODELING OF LONG-TERM FATE OF MOBILIZED FINES DUE TO DAM-EMBANKMENT INTERFACIAL DISLOCATIONS

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MODELING OF LONG-TERM FATE OF MOBILIZED FINES DUE TO DAM-EMBANKMENT INTERFACIAL DISLOCATIONS

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Transverse cracks in embankment dams can develop as a result of post-construction settlements, earthquake deformations, or anthropogenic loads such as emplaced explosives. During these dislocations, fine particles are released from the damaged zones and can create unwanted inertial erosion and piping through the transverse cracks. These processes are equally critical to the overall stability of the dam. We present numerical results related to the problem of the fluid flow, transport, and filtration of particulates from damaged zones between the concrete sections of a gravity dam and the embankment wraparound sections. The model solves simultaneously the flow, attachment, and washout of fine particles within a wraparound heterogeneous porous media. We used a state-of-the-art finite element method with adaptive mesh refinement to capture 1) the interface between water dense with fines and clear water, and 2) the non-linearity of the free surface itself. A few scenarios of sediment entrapment in the filter layers of a gravity dam were considered. Several parameterizations of the filtration model and constitutive laws of soil behavior were also investigated. Through these analyses, we concluded that the attachment kinetic isotherm is the key function of the model. More parametric studies need to be conducted to assess the sensitivity of the kinetic isotherm parameters on the overall stability of the embankment. These kinetic parameters can be obtained, for example, through numerical micro- and meso-scale studies. It is worth mentioning that the current model, for the more realistic non-linear kinetic isotherms, has predicted a self-rehabilitation of the breached core with retention of 50% of the mobilized fines using a very conservative filtration length. A more realistic value should exceed the assumed one, resulting in a retention exceeding 50%. This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344 and funded by the U.S. Department of Homeland Security, Science and Technology Directorate.